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CLINICAL EFFICACY AND ADVERSE EFFECTS OF AEROBIC EXERCISE ON ANXIETY DISORDERS

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ABSTRACT

Introduction: The number of people diagnosed with anxiety disorders is steadily rising, both in Europe and worldwide. This is serious problem, as these disorders significantly impar daily functioning and reduce quality of life. The ability to manage anxiety is crucial for healthy functioning in society. A growing body of research indicates that regular aerobic exercise can be an effective tool for reducing anxiety symptoms.
Aim: The aim of this study is to review the literature on anxiety disorders, their pathophysiology, and complications, and to describe the mechanisms by which aerobic exercise influences their development.
Methods and materials: A review of the literature available in the PubMed database was conducted using key search terms.
Conclusions: Aerobic exercise may be effective treatment for anxiety. It can enhance the effects of medication, but the evidence is still limited. Larger studies, improved methodology and longer-term follow-up of patient groups are needed. Exercise works better than rest. In healthy individuals, as well as those who have experienced trauma or have PTSD, a short session of aerobic exercise reduced anxiety and fear more effectively than lying down and resting. Even a small amount of physical activity helps reduce anxiety disorders.

KEYWORDS

Anxiety Disorders, Aerobic Exercise, Generalized Anxiety Disorder (GAD), Post-Traumatic Stress Disorder (PTSD)

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1. Introduction

1.1. Epidemiology

Anxiety disorders are among the greatest challenges of contemporary psychiatry, affecting approximately 1–3% of the general population, while the lifetime risk of developing them is estimated at 9%. Women are affected twice as often as men, indicating a clear gender disparity. The median age of onset is around 30 years, which significantly impacts patients' occupational and social functioning (Javaid et al., 2023; Solmi et al., 2022; 'The Role of Sex and Gender in Anxiety Disorders', 2020).

1.2. Etiopathogenesis

The etiopathogenesis of anxiety disorders is multifactorial and results from a complex interaction of biological and psychosocial determinants. From a biological perspective, a key role is attributed to the dysregulation of neurotransmitter systems—particularly within the GABAergic, serotonergic, dopaminergic, and noradrenergic systems (Martin et al., 2009). Significant neuroanatomical correlates include changes in brain structure, such as a reduction in hippocampal volume, as well as pathological hyperreactivity of the hypothalamic-pituitary-adrenal (HPA) axis. Although the contribution of genetic factors to the heritability of anxiety is estimated at 30%, environmental factors exert a dominant influence (approx. 70%) on the manifestation of the disorder (Hettema et al., 2001).

From a psychosocial perspective, a significant role is played by maladaptive cognitive schemas (faulty thinking patterns), unresolved intrapsychic conflicts, and deficits in the primary family environment (Bandelow & Michaelis, 2015). The main demographic and sociological risk factors predisposing to the development of the aforementioned disorders include female gender, early adulthood, low socioeconomic status, and social isolation (Penninx et al., 2021).

1.3. Diagnostics

The diagnostic process in the field of anxiety disorders, including generalized anxiety disorder (GAD) and post-traumatic stress disorder (PTSD), is based on a multidimensional clinical assessment conducted by a psychiatrist. The foundation of the diagnosis is an in-depth, structured clinical interview supported by the use of standardized psychometric tools (First & Tasman, 2006).

In the course of generalized anxiety disorder, the clinical picture is dominated by persistent, excessive anxiety and anticipatory worry regarding routine activities and everyday events (Newman et al., 2002). A widely recognized screening tool in this area is the Generalized Anxiety Disorder 7-item scale (GAD-7) (Spitzer et al., 2006). Obtaining a score of 10 points or higher indicates clinically significant symptom severity, demonstrating a strong correlation with the progressive impairment of the patient's psychosocial functioning (Kroenke et al., 2007).

On the other hand, the diagnosis of PTSD is directly linked to exposure to a traumatic event whose intensity exceeds the individual's defense mechanisms and adaptive capacities (Shalev et al., 2017).

2. Methods

This study has a review-based design focused on systematic medical information retrieval. The research material was collected from the PubMed database using targeted search queries. The analysis included randomized controlled trials (RCTs), systematic reviews, meta-analyses, and clinical studies addressing the clinical efficacy, biological mechanisms, and potential adverse effects of aerobic exercise on anxiety disorders, specifically generalized anxiety disorder (GAD) and post-traumatic stress disorder (PTSD).

Particular attention was paid to publications describing the multidimensional mechanisms of aerobic training (e.g., modulation of neuromodulatory and endocannabinoid systems, HPA axis regulation) across various patient cohorts, including healthy individuals, trauma-exposed groups, and populations with intellectual disabilities. The data evaluation involved comparing available clinical findings and standardized psychometric metrics (such as GAD-7 and HARS). Priority was given to contemporary studies providing high-quality scientific evidence to support the integration of structured aerobic interventions into standard psychiatric treatment protocols.

3. Aerobic exercise

The mechanism by which aerobic exercise affects a patient's mental state is a multidimensional process involving a series of biological and psychological cascades:

- Modulation of neuromodulatory systems: Intensive physical activity stimulates the central nervous system to increase the synthesis and release of endogenous opioids (endorphins) and endocannabinoids. These substances, often referred to as "happiness hormones," exhibit natural anxiolytic (anti-anxiety), analgesic, and euphoriant properties, which directly translates into mood stabilization (Gupta et al., 2024; Kandola et al., 2018).
- Reduction of somatic components of anxiety: Systematic training promotes the reduction of neuromuscular tension, which is one of the key components of the physiological response to stress and chronic anxiety (Kandola et al., 2018).
- Optimization of cerebral perfusion and metabolism: Aerobic exercise (e.g., long-distance running) improves cardiovascular hemodynamics. This results in more efficient cerebral perfusion, increasing the supply of oxygen and nutritional substrates to neurons, thereby supporting processes of neuroplasticity and overall cognitive performance (Northey et al., 2018).
- Regulation of the neuroendocrine (HPA) axis: Regular physical activity leads to the desensitization and normalization of the hypothalamic-pituitary-adrenal axis activity. The outcome of this process is a decrease in resting cortisol (the stress hormone) levels, which alleviates physiological and psychological anxiety reactivity (Gupta et al., 2024).
- Psychological and cognitive determinants: From a psychological perspective, regular physical exercise induces positive changes in the structure of the "Self". It correlates with an increase in self-efficacy, improved perception of one's physical well-being (body image), and facilitates processes of cognitive defusion, allowing for the reduction of intrusive thoughts and the "clearing" of thought processes (Mahindru et al., 2023).

4. Clinical studies

4.1. Aerobic exercise and the endocannabinoid mechanism

In a study conducted on a cohort of 54 individuals (age range 18–54 years), the effect of an acute exercise session on anxiety levels in patients with varying histories of trauma exposure was analyzed. The participants were divided into three cohorts: healthy individuals (control group), trauma-exposed individuals without PTSD symptoms, and patients diagnosed with post-traumatic stress disorder (PTSD).

The research procedure involved a 30-minute moderate-intensity cycling session, which was compared to an analogous period of rest (reading). To assess anxiety reactivity, the NPU-threat task paradigm was utilized, measuring the response to predictable and unpredictable aversive stimuli (mild electrical shocks).

The results demonstrated that across all groups, the level of anticipatory anxiety was significantly lower following the physical exercise session compared to the resting condition. Concurrently, a significant increase in plasma endocannabinoid concentrations was noted—specifically anandamide (AEA) and 2-arachidonoylglycerol (2-AG). This confirms the hypothesis of endocannabinoid system activation as a biological mediator of exercise-induced anxiety reduction (Crombie et al., 2021).

4.2. Effectiveness of exercise interventions in primary care

To evaluate the clinical efficacy of aerobic training, data from primary care centers in Gothenburg were analyzed. The systematic review encompassed 28 randomized controlled trials (RCTs) conducted on a cohort of 2,265 participants within the age range of 18–65 years. Inclusion criteria for the analysis required a clinical diagnosis of anxiety and depressive disorders, along with the utilization of standardized measures of symptom severity.

Results obtained following a 12-week intervention cycle demonstrated that systematic aerobic exercise leads to a statistically significant reduction in anxiety and depressive symptomatology, yielding a moderate effect size. Importantly from a clinical practice perspective, the therapeutic impact of physical exercise was also observed in patients undergoing antidepressant pharmacotherapy, suggesting the high efficacy of training as an adjunctive treatment. Furthermore, the analysis revealed that the degree of clinical improvement is positively correlated with the regularity of training sessions and the total duration of the therapeutic program (Wall et al., 2024).

4.3. Aerobic training in intellectual disability

To assess the universality of the therapeutic effects of physical activity, the results of a study conducted on a cohort of middle-aged patients (45–55 years) with intellectual disabilities were analyzed. The aim of the study was to compare various forms of physical activity in the context of their anxiolytic potential. Participants were randomized into three intervention groups:

Group I (aerobic training): Undertaking an exercise program on a treadmill and a cycle ergometer (frequency: 3 training sessions per week; duration: 20 minutes; intensity: 50–70% of maximum heart rate) for a period of 6 months.

Group II (functional training): Focusing on movement games and exercises stimulating proprioception and balance.

Group III (control): Comprising individuals not engaging in systematic physical activity.

To measure symptom severity, the Hamilton Anxiety Rating Scale (HARS) was utilized, having been previously adapted to accommodate the cognitive and communicative capacities of individuals with intellectual disabilities.

The final analysis demonstrated that both Group I and Group II exhibited a statistically significant reduction in anxiety levels compared to the control group. These results suggest that structured physical activity programs—both aerobic and functional—constitute an effective method of non-pharmacological mental health support in this population, irrespective of the degree of cognitive deficits (Chong et al., 2022).

4.4. Adverse effects

In the analyzed clinical trials, no serious adverse events were reported, which confirms the high safety profile of aerobic training in the population of patients with anxiety disorders. The observed bodily reactions were confined to the typical physiological consequences of aerobic exercise. These included increased perspiration, transient tachycardia, an elevated respiratory rate, and localized muscle fatigue in the lower extremities. These symptoms were transient in nature and directly correlated with the intensity of the undertaken activity, thus not constituting a contraindication to continuing the therapeutic protocol (Chong et al., 2022; Crombie et al., 2021; Wall et al., 2024).

5. Summary

This literature review has allowed for a comprehensive analysis of the mechanisms and an assessment of the clinical efficacy of aerobic exercise in the treatment of anxiety disorders. The gathered scientific evidence unequivocally indicates the significant role of physical activity in reducing anxiety and stress symptomatology across various age groups.

The key findings drawn from the analysis are:

- Non-linear effect: Even a low intensity and short duration of physical activity generate measurable health benefits, which is of significant importance for patients with low baseline fitness.
- Therapeutic synergy: Aerobic exercise constitutes a valuable complementary method that significantly enhances the efficacy of antidepressant and anxiolytic pharmacotherapy.
- Psychosomatic impact: By reducing neuromuscular tension and optimizing cerebral metabolism, exercise affects both the physiological and cognitive components of anxiety.
- Universality: The positive impact of aerobic training has also been observed in special populations, which confirms the broad spectrum of applications for this form of intervention.

Based on the above analysis, it can be concluded that the implementation of systematic aerobic activity into standard treatment protocols for anxiety disorders appears to be justified not only by its high efficacy, but also by its excellent safety profile and low implementation costs.

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